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ABSTRACT

This study examined whether there was a relationship between preservice elementary teachers' competency in science process skills and attitudes toward the field of science. Study data came from 46 students enrolled in an elementary math and science methods course during their first senior semester, just before entering student teaching. Study instruments included: (1) the Test of Integrated Processing Skills (TIPS II), which measured science process skills (identifying variables, operationally defining variables, identifying appropriate hypotheses, interpreting data, and designing instruments) and (2) a revision of the Fenneman-Sherman Mathematics Attitudes Scale, which predicted attitudes toward science using six subscales (confidence in learning science, teacher, usefulness of science, science as a male domain, science anxiety, and effectance motivation in science). Data analysis found a significant positive relationship between how well teachers performed science process skills and their attitudes toward science. The two subscales that significantly correlated with the performance of science process skills were the confidence in learning science scale and the teacher scale (which measured confidence in the ability to learn and perform well in science and how participants perceived their teachers' attitudes toward them in relation to their performance and/or their potential to do well in science). (Contains 23 references.) (Author/SM)

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SCIENCE PROCESS SKILLS AND ATTITUDES OF PRESERVICE ELEMENTARY TEACHERS

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SCIENCE PROCESS SKILLS AND ATTITUDES OF PRESERVICE ELEMENTARY TEACHERS

by

Jan E. Downing, Janet D. Filer, & Robert A. Chamberlain

Abstract

This study was conducted to determine if a relationship exists between preservice elementary teachers' competency in science process skills and their attitudes toward the field of science. The Test of Integrated Process Skills II (TIPSII) was the instrument selected to measure science process skills. A revision of the Fenneman-Sherman Mathematics Attitudes Scales (SAS) was used as a predictor of the subjects' attitudes toward science. The SAS consisted of six subscales also examined in the study. The hypothesis for the study stated that elementary perservice teachers who demonstrated a high competency in process skills would also indicate positive attitudes toward science. The data were collected while subjects were enrolled in an elementary math and science methods course during their first senior semester and just before entering student teaching. Analysis of the data indicated a significant positive correlation between elementary preservice teachers' ability to perform science process skills and their attitudes toward science. Upon analyzing the data collected on the six subscales, a significant positive correlation was found between the TIPS II and the Confidence in Learning Science Scale, and the Teacher Scale.

INTRODUCTION

Recent studies have indicated that elementary preservice teachers do not feel adequately prepared for teaching science content areas (Rice & Roychoudhury, 1994). However, Harlen and his colleagues (1995) found that new teachers who recently graduated expressed more confidence in teaching science than those with more experience; and those with courses or training intended to prepare teachers for the teaching of science were more confident than those with none. Harlen et al. also found that teachers who were already in the classroom were less confident about teaching science and technology than any other curriculum area.

While many teachers felt that they could cope with teaching science, their attitudes expressed a weakness in their own understanding of science process skills. In addition they did not feel adequate in facilitating conceptual development in their students (Radford, DeTure, & Doran, 1992). Some teachers who find strategies to cope with science in the classroom may create science instruction as little as possible to avoid having to deal with a subject they feel uneasy teaching. Because confidence levels are low, teachers may keep questioning, brainstorming, and class discussions to a minimum. Science concepts and topics are limited to those the teacher feels most comfortable addressing in an effort to minimize awkward teacher performance in the classroom (Rice, & Roychouldhury, 1994). Similarly, teachers who demonstrate low levels of confidence may avoid simple, practical, and valuable science experiments and other experiences due to fear that something might go wrong. Unfortunately expository teaching may become the method of choice for teaching science for those teachers who do not feel comfortable addressing science skills and concepts (Harlen, et.al, 1995). Research on pedagogical concepts in teaching science process skills support the notion of a relationship between confidence and understanding science. It appears that even with the increased attention math and science have been and are receiving, the education profession continues to produce teachers who perform science process skills inadequately (Harty, & Enochs, 1985).

These necessary skills include classifying, creating models, formulating hypotheses, generalizing, identifying variables, inferring, interpreting data, making decisions, manipulating materials, measuring, observing, predicting, recording data, replicating, and using numbers to determine relationships, or calculate or apply mathematical formulas

(Carin & Sund, 1989). Blosser (1975) believed that one of the most important contributions a teacher can make to students' future success in education is to provide them ample opportunities to learn and use science process skills. However, only those teachers who themselves have mastered the skills can successfully pass them on to their students (Funk, Fiel, Okey, Jaus, & Sprague, 1985). In addition, whether an elementary teacher performs well and properly facilitates science instruction in the classroom is influenced not only by the teacher's knowledge of science, but equally important are his/her feelings or attitudes toward those cognitions (Watter, 1994). Preservice elementary teachers cited prior science learning experiences and field experiences as sources of negative feelings and beliefs surrounding the idea of science teaching (Jasalavich, 1992). Several studies indicated that the effect of teachers' attitudes on students' attitudes is profound (Brush, 1979; Demers & Shrigley, 1990; Haladyna & Shaughness, 1982; Zeitler & Barufaldi, 1988). Therefore, identifying factors that contribute to positive attitudes in science should be made a priority of research for science educators (Thompson & Shrigley, 1986). Science attitude, labeled emotional intensity toward science and science teaching, affects how science is taught, how much of it is taught, or even *if* it is taught. The good news is negative attitudes toward science and science teaching can be changed. Fostering positive attitudes in both genders is possible by providing successful experiences for students using science process skills, and through manipulation of science equipment from kindergarten through college (Bitner, 1993). Providing positive science experiences for children increases the probability of producing more individuals who are not fearful of science and may learn to embrace science. Thus, replacing anxiety with genuine interest.

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METHOD

The sample consisted of 46 preservice elementary teachers enrolled in a mathematics and science methods course during their senior year and just before entering student teaching. Both instruments (TIPS II and SAS) were administered during the first week of the semester. A Pearson Product Moment Correlation Coefficient (r) was calculated to determine if a relationship existed between the TIPS II and SAS scores. Correlation coefficients were also calculated to determine if a relationship existed between the TIPS II scores and scores obtained from the six subscales of the SAS.

INSTRUMENTATION

Test of Integrated Process Skills II (TIPS II)

Mechling & Oliver (1983) stated that science process skills can be tested with accuracy by standardized tests. The TIPS II (Okey, Wise, & Burns, 1982) is the instrument chosen to measure the proficiency level of process skills of the subjects. Other instruments designed to detect and measure the level of proficiency of process skills are available, but the TIPS II was found to be a frequently used instrument that yields satisfactory results for the purpose of similar research (Downing, & Gifford, 1996; Germann, 1989; Scharmann, 1989; Strawitz, 1989). Strawitz (1989) reported a reliability of .89 (Cronbach's alpha). She also stated that the TIPS II contains satisfactory content validity. The TIPS II is a 36-item, multiple choice instrument that measures the following skills:

1. Identifying variables
2. Operationally defining variables
3. Identifying appropriate hypotheses
4. Interpreting data
5. Designing experiments

Science Attitudes Scales (SAS)

The SAS is a revision of the Fennema-Sherman Mathematics Attitudes Scales (Cochran, 1992; Fennema & Sherman, 1976). Of the 72 items, there are 36 positive items and 36 negative items. The SAS is a likert-scale test that consists of five item responses reflecting subjects' attitudes toward science. Subjects are to indicate the extent to which they agree or disagree with the ideas expressed.

Example:	Science is very interesting to me.			
A. Strongly Agree	B. Agree	C. Undecided	D. Disagree	E. Strongly Disagree

In order to convert this data to interval strength, a numerical value was assigned for each letter (Cochran, 1992). For the 36 positive items, the following assignments were made: A = 5; B = 4; C = 3; D = 2; E = 1. In dealing with the 36 negative items, the reverse assignment was made so that a more accurate interpretation of the results could be obtained.

There are six subscales in the SAS instrument. The name of the scales and the split-half reliability for each scale is listed in Table 1 (Fennema & Sherman, 1976).

Table 1
Split-half Reliability for Science Attitudes Scales

SAS Subscales	Split-half Reliability
Confidence in Learning Science Scale	.93
Teacher Scale	.88
Usefulness of Science Scale	.88
Science as a Male Domain Scale	.87
Science Anxiety Scale	.89
Effectance Motivation in Science Scale	.88

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Included in the following discussion is a brief explanation of the six subscales to provide the reader insight as to what areas each scale measures. The Confidence in Learning Science Scale is designed to measure subjects' confidence in their ability to learn and perform well on science tasks. This scale's items range from obvious lack of confidence to definite confidence. The Teacher Scale is intended to measure how participants perceive their teachers' attitudes toward them in relation to their performance and/or their potential to do well in science. The usefulness of science as it relates to current and future endeavors of the participant is measured in the Usefulness of Science Scale. Subjects are to express whether or not science has or will effect their vocations as well as other activities. The intent of the Science as a Male Domain Scale is to determine the subjects' perceptions of the relative ability of the sexes to perform in science. Feelings of discomfort and anxiety related to science are measured by the Science Anxiety Scale. Items range from feelings of ease to distinct anxiety. The effectance as applied to science is measured in the Effectance Motivation in Science Scale. Items range form lack of involvement in science to active involvement and seeking challenge.

Fennema and Sherman (1976) established content validity by defining each scale dimension and independently writing items representing those dimensions. Each author judged the other's items and an agreement for each item used was established.

DATA ANALYSIS

A Pearson Product Moment Correlation Coefficient (r) was the statistical procedure chosen to ascertain the magnitude of the relationship between the subjects' science process skills and attitudes toward science. This procedure is commonly used in determining the extent of a relationship existing between variables and is probably used most frequently in educational research (Van Dalen, 1973). Typically, correlational studies do not require large samples. If a relationship exists it is assumed that it will be

evident in a sample of moderate size (Ary, Jacobs, & Razaviek, 1985). A Pearson Product Moment Correlation Coefficient (r) was calculated between TIPS II scores and SAS scores. In addition, correlation coefficients were also calculated between TIPS II and the scores produced in the six subscales of the SAS. The level of significance was set at ($p = .05$).

Results indicated that there was a moderate positive correlation between the subjects' competency levels of science process skills and attitudes toward science ($r = .39$). The examination of coefficients determined between TIPS II and the six SAS subscales resulted in the following; a moderate positive correlation was noted between the TIPS II and the Confidence in Learning Science Scale ($r = .29$), and the Teacher Scale ($r = .33$). The remaining four subscales resulted in no significant findings.

CONCLUSIONS

The results ascertained from this study support the notion that a relationship exists between how well a teacher performs science process skills and his/her attitude toward science. It is interesting to note that the two subscales significantly correlated with the performance of science process skills are the Confidence in Learning Scale and the Teacher Scale, recalling that these scales measure confidence in the ability to learn and perform well in science, and how subjects perceive their teachers' attitudes toward them in relation to their performance and/or their potential to do well in science.

With science and technology advancing at such an astronomical rate, the pressure to produce teachers who are scientifically and technologically literate will remain on university teacher preparatory programs. The information obtained through this study may be used to encourage the design of teacher preparatory courses to include emphasis on science process skills and assist new teachers in becoming confident in using and assessing these skills in elementary classrooms so that these skills may be successfully passed on to their students. As future teachers experience more success while building

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confidence in performing science process skills, they may also demonstrate positive attitudes toward science in their classrooms. In an effort to continue improvement of teacher preparatory programs, additional research is recommended to identify other factors that may have a relationship with competency in science process skills, confidence levels, and attitudes of elementary teachers.

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